



A.N.T. INTERNATIONAL®

*Boosting your Excellence through Knowledge and Training*



A.N.T. INTERNATIONAL®

**IZNA™**

---

## **Information on Zirconium Alloys Programme**

The Annual IZNA Programme is focused on fuel assembly material issues and open to fuel vendors, regulators and research laboratories.

# IZNA22 Programme

---

## *Objective*

The overall objective of the IZNA Programme is to:

Interpret published R&D results and nuclear plant experience on Zr alloy materials to help the customer to make informed decisions for the improved reliability, safety and economics of operations.

Point out areas where more R&D is needed to resolve potential issues (indications just seen but no problem yet).

The objective is met through review and evaluation of the data on zirconium alloys, identification of the most important new information, and discussion of its significance in relation to fuel performance now and in the future.

The IZNA22 Programme consists of Reports and presentations related to the Reports and on other topics not covered in the IZNA22 reports.



## *IZNA22 Special Topic Report*

The Special Topic Report will cover the range from basic information to current knowledge and be written and explained in such a way that engineers and researchers not familiar with the topic can easily follow the STR, find and grasp the appropriate information. This means that the STR could be used by the organisations in the training of their internal staff with or without the additional assistance of A.N.T. International staff. The background and proposed content of the Report is discussed in detail below.

## **Pellet-Cladding Interaction (PCI and PCMI): progress in nuclear industry**

Pellet-Cladding Interaction (PCI) and Pellet-Cladding Mechanical Interaction (PCMI) remains an important phenomenon in the modern nuclear reactor fuel engineering. This topic was addressed in detail in IZNA-6 Special topical report on PCI issued in 2006. Since then, a substantial development has taken place, such as introduction of new cladding materials and additive fuel pellets. In addition to this, flexible power operation is being considered by many utilities worldwide. This introduces new challenges to the safe and reliable operation of the nuclear fuel.

**This report addresses the new developments in the following areas:**

- PCI and PCMI research
- Advances in PCI modelling
- PCI/PCMI in ATF fuels
- Cladding behaviour under flexible operation,
- Pre-conditioning interim operating management recommendations (PCIOMR)
- Laboratory testing techniques for PCI/PCMI properties of fuel cladding

The report discusses up-to-date developments in the above mentioned areas and summarizes the main outcomes of the R&D work performed since 2006.



**“My company joined the IZNA Program in year 2003 starting with the IZNA1 and IZNA2. Since that year until now, products offered by ANT International have been one of the main source of information for the training of our new engineers.”**

*Cristina Muñoz-Reja Ruiz*  
*Enusa*

## Updated RIA Topic Report

The design basis RIA in a PWR is the Control Rod Ejection (CRE), while in a BWR, it is the Control Rod Drop Accident (CRDA). The CRE is based on the assumption of a mechanical failure of the control rod drive mechanism located on the reactor vessel top, followed by the ejection of the mechanism and the control rod by the internal reactor pressure. The resulting, significant power surge is limited partly by Doppler feedback and finally terminated by the reactor trip. The BWR CRDA is assumed to occur if a control rod is detached from its drive mechanism in the core bottom, stays stuck while inserted in the core, then if loosened, drops out of the core by gravity, without involvement of a change in reactor pressure as in the CRE. Partly as a result of these differences, the BWR power pulses are slower than for a PWR. The pulse widths for PWRs are in the range of 10–30 ms and for BWRs in the range of 20–60 ms.

The content of the Updated RIA is basically the same as the original report (see: [https://www.antinternational.com/docs/samples/FM/05/first\\_chapter\\_zirat\\_11\\_PCI\\_PCMI.pdf](https://www.antinternational.com/docs/samples/FM/05/first_chapter_zirat_11_PCI_PCMI.pdf)) however a number of sections and subsections are revised and complemented with additional information. The main focus of the update is on two major subjects: (1) new RIA tests and the interpretation of the results and (2) new RIA related regulations. New RIA tests will complete the existing data base and their potential significance for RIA modelling or for RIA ruling. New acceptance criteria for RIA issued by US NRC are briefly described as well as some national approaches, different from the US NRC.



## *Deliverables*

### **A.N.T. International will provide the IZNA Members with the following:**

- **Searchable electronic report version with the following contents:**
  - » High-resolution pdf files with complete IZNA Special Topic Reports in colour.
  - » The files can be copied to a company server, with full read access for everybody with access to the server.
  - » The contents from the Special Topic Reports in pdf-format can be printed. Also, the contents from the pdf-files can be copied and pasted electronically into other documents, e.g. Word files.
  - » All figures and tables with A.N.T. International copyright can be used by the member both internally and externally provided that the source is provided in the caption.
- **Before the seminars, you will have access to:**
  - » The complete IZNA Reports in digital format (PDF)
  - » The contents of all the seminar presentations in high-resolution PDF format
- **The language of the IZNA Programme will be English.**
- **The authors will be available for consulting throughout the year. A few telephone or e-mail consultations requiring no additional work are provided at no additional cost to Members.**
- **IZNA members have an option to purchase:**
  1. Previous IZNA reports at a 50% discount and
  2. 12 months access to A.N.T. International Online Education Courses at a large discount
  3. Consulting hours related to large projects for a discounted hourly rate



## *Bios of IZNA22 Report Authors*



**Dr. Audrius Jasiulevicius** had completed his Ph.D. in the Nuclear Power Safety in 2003. Since then he had been working in the nuclear industry. He had been working with various aspects of the nuclear technology: thermal hydraulics system code development and applications, safety analysis, nuclear fuel licensing, nuclear fuel materials and material performance, nuclear fuel manufacturing processes and supplier quality evaluation. In 2003-2007 Audrius worked as a researcher and nuclear engineer at Paul Scherrer Institute in Switzerland. In 2007-2019 he was employed at Vattenfall Nuclear Fuel AB company in Sweden. In his free time Audrius enjoys spending time with his children, travelling to new places and reading. His is an experienced diver and this activity is still on the top of his preferences of leisure activities.



**Dr. Sheikh Tahir Mahmood** retired from Global Nuclear Fuel in 2012 as a Senior Engineer/Technologist for Fuels Engineering at the Vallecitos Nuclear Center. Earlier he received Masters degrees in Physics and Nuclear Technology from abroad and doctorate in Nuclear Engineering from North Carolina State University. His Post-doctoral work on mechanical anisotropy of zirconium alloys and radiation effects on reactor structural materials was done at NCSU and ORNL, respectively.

At GE Nuclear Energy/GNF, he was actively engaged in fuel performance and materials technology. This activity involved failure root-cause investigations through hot cell PIE of the failed in-core components, and development and evaluation of material property data bases for new materials developed for in-core use. Tahir has particular interest and experience in mechanical metallurgy, mechanical behavior of fuel, cladding and structural materials, and in-reactor behaviour of these materials for improved fuel reliability. He has actively participated in various international nuclear industry research programs.



**Mr. Marek Stepniewski** has more than 30 years' experience in the commercial nuclear industry and with his thermal-hydraulic background worked mostly in areas of transient and accident analysis as well as thermo-mechanical analysis and licensing of the nuclear fuel for both BWRs and PWRs. Recent years his interest was focused mostly on Design Basis Accidents in PWRs – LOCA and RIA – both as far as modern analysis methods and newly developed or updated acceptance criteria is concerned. He was involved in several international cooperation programmes like EPRIs Fuel Reliability Program, OECD/NEAs Working Group for Fuel Safety and OECD/Studsviks SCIP III project. He served as well as a member of the Thermal-hydraulic Reference Group for Swedish Nuclear Power Board (now Swedish Radiation Safety Authority).

Mr. Marek Stepniewski retired from the Vattenfall Nuclear Fuel AB in May 2020, where the last decade he served as Senior Company Adviser at the Nuclear Design and Analysis Department with responsibility for the following areas:

- Follow up international development of the safety analysis methods
- Initiate and assist own safety analysis methods development
- Assist resolution of complex technical issues
- Maintain competence development in the Department.

Mr. Marek Stepniewski has a degree (M.Sc.) in Nuclear Engineering from the Technical University Warsaw (Poland).

# Terms and Conditions

The term of IZNA22 Programme starts from the date of the purchase order and lasts 12 months onwards.

A.N.T. International shall exercise its best efforts to meet the objectives in this assignment and shall apply to the work professional personnel having the required skills, experience and competence. If the assignment is found to be significantly deficient by the customer within 6 months of its completion, A.N.T. International shall modify the work done within this assignment in such a way that it will become satisfactory to the customer. This modification shall be done without incurring any additional costs to the customer. The total amount of such additional costs due to the modification shall be limited to be less or equal to the amount originally paid to A.N.T. International for this assignment. It is understood that A.N.T. International is not responsible for any damage, incurred to the customer, their employees, or their plants or to a third party due to the use of the information or the re-recommendations given within this assignment.

The compiled information and the conclusions, as a result of this work, may be used by the purchasing party for its own use for any purpose provided that the source is given. A.N.T. International retains the rights to the compiled information and the conclusions for other uses.

## Nuclear Liability

A.N.T. International and its sub-suppliers, including also suppliers of information and services, of every tier and kind, and everyone engaged by any of them, shall have no liability whatsoever (irrespective of negligence or gross negligence) for any damage or loss whatsoever (including also consequential and indirect loss) resulting from a nuclear incident (as such term is defined in the Paris Convention on third party liability in the field of nuclear energy, as amended from time to time). This shall apply for damage or loss suffered by third parties or the owner and for damage and loss to the nuclear installation, on site property and any other property of any kind, and until the nuclear installation has been definitely decommissioned and irrespective of any termination or cancellation of the proposed work.

Insurances of the owner and of others in respect of a nuclear incident shall exclude any right of recourse against the supplier and his sub-suppliers of every tier and kind.



A.N.T. INTERNATIONAL®



A.N.T. INTERNATIONAL®

## CONTACT

For more information and/or an offer, welcome  
to contact us at [sales@antinternational.com](mailto:sales@antinternational.com)

---

Please also visit our website for the latest updated  
information [www.antinternational.com](http://www.antinternational.com)